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Sameer M. Ikhdair, Ramazan Sever

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The Klein-Gordon equation in  $D$ -dimensions for a recently proposed Kratzer potential plus ring-shaped potential is solved analytically by means of the conventional Nikiforov-Uvarov method. The exact energy bound-states and the corresponding wave functions of the Klein-Gordon are obtained in the presence of the noncentral equal scalar and vector potentials. The results obtained in this work are more general and can be reduced to the standard forms in three-dimensions given by other works.

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The Graham conjecture implies the Erdos-Turan conjecture

Liangpan Li

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THE GRAHAM CONJECTURE IMPLIES THE ERDŐS-TURÁN CONJECTURE

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ABSTRACT. Erdős and Turán once conjectured that any set  $A \subset \mathbb{N}$  with  $\sum_{a \in A} 1/a = \infty$  should contain infinitely many progressions of arbitrary length  $k \geq 3$ . For the two-dimensional case Graham conjectured that if  $B \subset \mathbb{N} \times \mathbb{N}$  satisfies

$$\sum_{(x,y) \in B} \frac{1}{x^2 + y^2} = \infty,$$

then for any  $s \geq 2$ ,  $B$  contains an  $s \times s$  axes-parallel grid. In this paper it is shown that if the Graham conjecture is true for some  $s \geq 2$ , then the Erdős-Turán conjecture is true for  $k = 2s - 1$ .

1. INTRODUCTION

One famous conjecture of Erdős and Turán [2] asserts that any set  $A \subset \mathbb{N}$  with  $\sum_{a \in A} 1/a = \infty$  should contain infinitely many progressions of arbitrary length  $k \geq 3$ . There are two important progresses towards this direction due to Szemerédi [7] and Green and Tao [5] respectively, which assert that if  $A$  has positive upper density or  $A$  is the set of the prime numbers, then  $A$  contains infinitely many progressions of arbitrary length.

If one considers the similar question in the two-dimensional plane, Graham [4] conjectured that if  $B \subset \mathbb{N} \times \mathbb{N}$  satisfies

$$\sum_{(x,y) \in B} \frac{1}{x^2 + y^2} = \infty,$$

then  $B$  contains the four vertices of an axes-parallel square. More generally, for any  $s \geq 2$  it should be true that  $B$  contains an  $s \times s$  axes-parallel grid. Furstenberg and Katznelson [3] proved the two-dimensional Szemerédi theorem, that is, any set  $B \subset \mathbb{N} \times \mathbb{N}$  with positive upper density contains an  $s \times s$  axes-parallel grid. In another words, such a set  $B$  contains any finite pattern.

The purpose of this paper is to show that if the Graham conjecture is true, then the Erdős-Turán conjecture is also true.

2. THE GRAHAM CONJECTURE IMPLIES THE ERDŐS-TURÁN CONJECTURE

Suppose that the Erdős-Turán conjecture is false for  $k = 3$ . Then there exists a set

$$A = \{a_1 < a_2 < a_3 < \dots\} \subset \mathbb{N}$$

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		<p>So I got the derivative of E-DB-1C at the direction of F is E-DB-1C, how can I draw the conclusion that it is surjective? As a matter of fact, I don't even sure if it is a good idea to differentiate in the <math>\mathfrak{F}</math> direction, since E-DB-1C is m-r row, n-r column matrix.</p>	
	<p>2</p> <p>LIANGPAN LI</p> <p>with <math>\sum_{n \in \mathbb{N}} 1/a_n = \infty</math> such that <math>A</math> contains no arithmetic progression of length 3. Define a set <math>B \subset \mathbb{N} \times \mathbb{N}</math> by</p> $B = \{(a_n + m, m) : n \in \mathbb{N}, m \in \mathbb{N}\}.$ <p>Then</p> $\begin{aligned} \sum_{(x,y) \in B} \frac{1}{x^2 + y^2} &= \sum_{n \in \mathbb{N}} \sum_{m \in \mathbb{N}} \frac{1}{(a_n + m)^2 + m^2} \\ &\geq \sum_{n \in \mathbb{N}} \sum_{m=1}^{a_n} \frac{1}{(a_n + m)^2 + m^2} \\ &\geq \sum_{n \in \mathbb{N}} \frac{a_n}{(a_n + a_n)^2 + a_n^2} \\ &= \sum_{n \in \mathbb{N}} \frac{1}{5a_n} \\ &= \infty. \end{aligned}$ <p>In the sequel we indicate that <math>B</math> contains no square and argue it by contradiction. This would mean that the Graham conjecture is false for <math>s = 2</math>. Suppose that for some <math>n, m, l \in \mathbb{N}</math>, <math>B</math> contains a square of the following form:</p> $\begin{pmatrix} a_n + m, m + l \\ a_n + m, m \end{pmatrix}, \quad \begin{pmatrix} a_n + m + l, m + l \\ a_n + m + l, m \end{pmatrix}.$ <p>It follows easily from the construction of <math>B</math> that <math>a_n - l, a_n, a_n + l \in A</math>, which yields a contradiction since <math>A</math> contains no arithmetic progression of length 3 according to the initial assumption.</p> <p>Similarly, if the Graham conjecture is true for some <math>s \geq 2</math>, then the Erdős-Turán conjecture is true for <math>k = 2s - 1</math>. The interested reader can easily provide a proof.</p>	<p>How do you define the tangent plane? What object exists given this data?</p>	
		<p>Let <math>f</math> and <math>g</math> be integrable in <math>[0,1]</math> and <math>(-\infty, \infty)</math> respectively. Let <math>a_k</math> be a divergent series of positive terms and <math>S_k = a_1 + a_2 + \dots + a_k</math> such that the following asymptotics hold.</p>	
		<p>Replace <math>g</math> with <math>g_n(x) = g(S_n x)</math>. Then <math>\sum_{n=1}^{\infty} \int_0^1 g_n(x) dx = \int_0^1 g(x) dx</math>. The lower limit is 0 because the ratio goes to zero in the limit.</p>	
	<p>3. CONCLUDING REMARKS</p> <p>Let <math>r(k, N)</math> be the maximal cardinality of a subset <math>A</math> of <math>\{1, 2, \dots, N\}</math> which is free of <math>k</math>-term arithmetic progressions. Behrend [1] and Rankin [6] had shown that</p> $r(k, N) \sim N \exp(-c_k) \quad \text{as } N \rightarrow \infty, \quad c_k \sim N^{1/(k-1)}.$	<p>The tangent plane at the point <math>u =</math> <math>(x_0, y_0, f(x_0, y_0))</math> of the function <math>g(x, y, z) = (x, y, z), z = f(x, y)</math>, is just <math>\nabla g(x_0, y_0, z_0) \cdot (x - x_0, y - y_0, z - f(x_0, y_0)) = 0</math>. This means the gradient of the function <math>f</math> exists at <math>(x_0, y_0)</math> and from another question you asked this means there exists the directional derivative of <math>f</math> in any</p>	

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